APPLICATION OF GROUP WAGE INCENTIVES TO SHIPPING AND WAREHOUSING OPERATIONS AND ITS EFFECT ON COST DISTRIBUTION

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Grover Nicholas Meinert

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INTRODUCTION

Modern industry in the present era of competition must operate with the lowest possible costs. The production of goods to be sold at a price that can and will be paid by the great numbers of the public can only be accomplished by a low producing cost. In order for management to analyze its costs so that reductions may be made, it must know the cost characteristics of each phase of its operation. Attention then can be directed to those phases where the greatest cost reduction can be made. To accomplish a reduction in costs much consideration has been given to ways and means for the determination of the cost of each operation and the reporting of such costs by various cost accounting procedures.

The field of Industrial Engineering is concerned with costs both from the standpoint of determining and of reducing them. The installation of a sound wage incentive plan will reduce costs in many circumstances.[1] Standards, as a part of any incentive plan, can also be very helpful in the determination of costs. It is possible to combine the functions of

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[1] Charles W. Lytle, Wage Incentive Methods (New York: The Ronald Press Company, 1942), p.53.

Cost Accounting and Industrial Engineering so as to arrive at more accurate and complete cost records.

Inasmuch as Cost Accounting and Industrial Engineering were not applied in industry at the same time, the two functions are usually operated under separate departments. It is the practice in some companies, however, to have the Industrial Engineering Department and the Cost Accounting Department report to the same official of the company. Reporting to the same official of the company by the two departments in many cases fails to create the intimate, cooperative relationship that should exist between the two. This thesis will present an instance in which functions of Industrial Engineering can be correlated closely with Cost Accounting.

A great deal of progress has been made in the application of time standards and cost distribution in the manufacturing phase of industry. By contrast, warehouse and shipping operations have generally been neglected in this respect because of the following reasons:

1. Customer orders have wide ranges both as to the types of products ordered and the quantities within these orders. This makes it necessary to develop standards that can be applied to cover such variations.
2. Jobs that are performed in a warehouse

cannot at times be performed in the repetitive manner as can many production jobs.

3. The frequency distribution of the weights and products of orders may vary with different seasons and changes in the general economic trend.
4. The lack of repetition in the performance of jobs makes it difficult to keep an accurate cost record of these operations.

The above reasons indicate a need for a technique to apply time standards and cost control to warehouse and shipping operations. The purpose of this thesis will be to develop this application in the following manner:

1. Present a wage incentive plan for operations performed in a warehouse.
2. Illustrate how a cost distribution system can become a part of the application.
3. Illustrate how standards may be applied on variable occurrences without the necessity of predetermining frequencies.
4. Develop a reporting procedure for this plan that will also be used in the cost distribution for the various

products and operations.

This application is illustrated by shipping and warehousing operations that are performed in the steel making, processing and fabricating industry. The study was made at the Atlantic Steel Company of Atlanta, Georgia.

REVIEW OF THE LITERATURE

A bibliographical search was made on the subject of warehouse incentives and cost distribution. This search was made to determine existing sound practices and techniques for the application of incentive plans and cost distribution systems and to locate articles on their application within the scope of this thesis.

It must be realized that Cost Accounting and Industrial Engineering are only a part of the efforts of management to secure a sound wage and accounting policy. To accomplish this objective it is necessary to follow the principles of sound wage incentives and cost accounting.

Various authorities generally agree on the requirements of a sound incentive plan. Lytle[2], Presgrave[3] and Shumard[4] have expressed these requirements in the following

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[2]Charles W. Lytle, Wage Incentive Methods (New York: The Ronald Press Company, 1942), p.71.

[3]Ralph Presgrave, Dynamics of Time Study (New York: McGraw-Hill Book Company, Inc., 1945), p.121.

[4]F. W. Shumard, Primer of Time Study (New York: McGraw-Hill Book Company, Inc., 1940), p.283.

principles:

1. The individual should be rewarded in proportion to his own effort. It should be realized that in many instances it is impossible for the employee to set the pace at which he is to work. Assembly operations as well as machine operations in many cases determine the amount of work the employee is able to perform.
2. The standards should be set so that they can be made by qualified operators when extra effort is exerted. This principle is probably one of the most important. A standard that does not provide an opportunity to make expected earnings will invariably result in a low performance ratio.
3. The daily or pay period ratio should be posted or given the employees as soon as practical. This will enable the employees to have a better knowledge of the amount of work associated with the extra pay.
4. The incentive plan should be simple

in that the employee should be able to know how much production is required for extra pay. An employee usually will not exert extra effort just in hopes of making extra pay. If the employee knows after he has been working on standard several hours that he is making extra pay, it provides a strong incentive for him to continue to work at this rate so as not to lose this extra pay.

5. The incentive plan should be clearly expressed in writing so that proper administration can be maintained by the operating department supervisors and proper controls by the department in the company responsible for maintaining the standards. It should be remembered that the person who develops an incentive plan may not remain in his same capacity and that the standards must be controlled and maintained by persons who can only use what has been written in the incentive plan.

6. No standards should be changed unless

there is a change in the job. This is usually referred to as the "guarantee of standards" which should be a part of all incentive plans. This guarantee states that as long as the conditions under which the standards were set are unchanged, the standard shall remain the same.

7. The reporting systems should be simple so as to permit easy, accurate, and fast computation of extra pay.
8. The incentive plan as a whole should fit into other functions of wages and cost accounting. This principle will be discussed in detail later in the thesis.
9. Production reports should be made by persons other than those who benefit from the earnings. This principle has led, in many instances, to the establishment of a separate department that is responsible for weighing, counting and reporting the production.
10. Proper inspection procedure of the product on standard should be maintained. Much discussion has

occurred as to the effect on quality of the application of standards. Emphasis is naturally placed on quantity of production by the application of standards as extra pay is earned by making more units. As the production is increased the quality may decrease due to the change of the operator's pace. Proper quality will again be attained as soon as the operator adapts his skill to the faster speed. Production that does not pass inspection is usually not counted for incentive earnings.

11. In the application of group incentives, there should be a clear understanding by the group of the effect of each individual on the performance ratio and consequently the earnings of the group.

It should be kept in mind when applying these principles that incentive plans are installed as a means to an end. They are not installed as ends in themselves. This is sometimes not considered in their application since more emphasis is frequently placed on the derivation of the incentive plan than on the desired result. A major purpose of the incentive plan is to provide an opportunity for an individual or a group of employees to be rewarded for a measured amount of work performed during a given period of time.

The field of cost accounting is very broad in its application, but there are certain commonly recognized principles as reported by Donald M. Russell.[5] These are:

1. Accounting reports and source data must be objective and verified.

2. Accounting must be related to a specific entity.

3. Accounting, to be adequate, must trace the flow of funds.

The principles of wage incentives and cost accounting in many instances can be combined to produce more accurate and complete cost records. This thought has been aptly expressed by Phil Carroll, Jr.[6]

> "If we agree that sound incentives are a part of good operations, then we should make full use of time standards set up for them. We should utilize the common denominator of measured time instead of changing thousands of details into dollars to get a measuring stick that is much

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[5] Donald M. Russell, "Application of Generally Accepted Principles to Cost Accounting," NACA Bulletin, 29:1535, August 15, 1948.

[6] Phil Carroll, Jr., "Where Cost Accounting and Industrial Engineering Meet." The Journal of Accounting, 87:636, April, 1949.

> less reliable. We should make the most of the speed afforded through incentive reporting to get control indicators that react almost instantaneously."

This same thought has been expressed by R. Conrad Cooper, Vice President in charge of Industrial Engineering for the United States Steel Corporation.[7]

1. The activities of accounting and industrial engineering are closely related, interdependent and complementary.
2. The successful discharge of either function in its full scope is contingent upon the cooperative handling of both.

The search was also made to locate articles on the combination of wage incentives and cost distribution in warehouse applications. The only article located was one written by C. Mors and F. Prochaska.[8] This article dealt only with the problem of the application of standards to shipping operations. It did not consider the application of a cost distribution system to be used in conjunction with the incentive plan.

The article by C. Mors and F. Prochaska concerned

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[7] R. Conrad Cooper, "Interdependence of Industrial Engineering and Cost Accounting," NACA Bulletin, 31:951, April, 1950.

[8] C. Mors and F. Prochaska, "Packing and Shipping on Incentives," Mill and Factory, (October, 1948), pp.140-142.

itself mostly with the reasons for replacing a group incentive with an individual one. The difficulties that were encountered in the group plan were not due entirely to the fact that it was a group plan, but rather that the standards were based on an average of widely dispersed weights and products. The result was that employees were rewarded more on the size and products in an order than on the effort used to fill these orders. This inequity was corrected when the application was changed to an individual basis.

The search included the Industrial Arts Index 1945-1951, published by H. W. Wilson Company; and Engineering Index 1945-1951, published by Engineering Index Incorporated.

DEFINITIONS OF TERMS USED

The following terms will be used throughout the thesis. An explanation of the terms is given here for a clearer understanding of their usage.

Warehouse. An area where material is stored after all operations have been performed by the producing departments.

Warehousing. The work "warehousing" shall be used as a broad term to include those operations performed in the warehouse exclusive of shipping. These operations can at times be performed more economically in the warehouse than in the operating department. Straightening, bundling, and placing material in storage bins by hand are examples of these operations.

Normal time. Normal time shall be considered as the time for a qualified operator to perform an operation at a normal or natural rate of speed while using necessary allowances. This speed, as expressed in the agreement between the United States Steel Corporation and the United Steelworkers of America dated May 8, 1946, is equivalent to a man walking, without load, on smooth, level ground at a rate of three (3) miles per hour.

Allowances. Allowances shall be expressed in this thesis as a percent of the normal time to be added to the normal time for personal needs, rest, starting up, cleaning up at the end of the turn, and contingencies. All other times such as set up time shall be included in the cycle as determined by time study.

Performance Ratio. This shall be the ratio of the hours earned by the working forces to the hours worked on standard. As an example, if ten hours are earned with eight man hours applied on standard the performance ratio shall be 1.25. This ratio is usually expressed as a percentage, i.e. 125%.

Time Study. A procedure for establishing the standard time for an operation which consists of recording the elements of a job in the order in which they occur and the time elapsed for their performance. All time studies were made with the use of a decimal minute stop-watch.

Rating. Rating is a means of converting an observed time value to a normal time. A qualified operator performing an operation at a normal or natural rate of speed is rated at 100. An operator performing at a rate of 20 percent above normal is rated 120.

Cycle Time. The cycle time is the total time of all the elements that are performed in an operation. All the elements in the cycle do not necessarily occur with the same frequency.

Guaranteed Base Rate. Minimum rate of pay the operator is guaranteed per hour while performing the job to which he is assigned.

Percent Extra Pay. The percent extra pay is that percent as determined by the performance ratio, that is to be multiplied by the guaranteed base rate times the hours worked on incentive to determine the extra pay earned.

TYPES OF INCENTIVE PLANS

The standards for an incentive plan may be determined by time study, methods time measurement, past production records, standard costs or other techniques such as the Scanlan Plan.[9] As all standards in conjunction with this

[9] Russell W. Davenport, "Enterprise for Everyman," Fortune, 41:55-59, January, 1950.

study were determined by time study, this discussion will be limited to types of plans used with time study.

A large number of different incentive plans have been formulated containing various earning curves, controls and policies. These plans can be considered to be a variation of five types.[10] A brief discussion of each of these types is given:

Standard Hour Plan.

The emphasis in this type of plan is placed on the number of hours earned. The employee is paid the earned hours rather than his attendance hours. The extra pay depends upon the rate the individual is paid per hour. This allows the same standard to be used with variations in earnings due to such factors as seniority on job qualification. In the event of wage adjustments under this plan it is only necessary to adjust the base rate.

Piece Rate Plan.

The piece rate plan is probably the oldest type of incentive plan and it is also one of

[10] Charles W. Lytle, Wage Incentive Methods (New York: The Ronald Press Company, 1942) pp.124-326.

the simplest. Emphasis in this type of plan, is placed on the number of pieces produced. In the event of wage adjustments under this plan it is necessary to change a large number of standards. The amount of change is difficult to compute if the adjustment is to be based on wages per hour. This plan is now ordinarily used with a guaranteed day rate.

Premium Sharing Plans.

This type of plan differs from the piece rate and standard hour plan in that the benefits of increased production are shared both by the management and the employee. The different earning curves for this type of plan are unlimited and may be adapted so as to have various earnings at different levels of production. This type of plan has been adapted in many instances to group application.

Point Plans.

The original point premium plan was first applied in 1919 by Charles E. Bedoux. This plan is based on units of work earned and is set so that 60 units per hour constitutes standard and 80 units per hour constitutes the expected ratio for qualified operators. Bedoux applied this plan with emphasis on the reports and controls for employees and departments rather than on the earning curve.

Measured Day Work.

This plan was devised as a compromise between a regular incentive plan and a non-incentive time plan. Its extra compensation is based on such personal virtues, as, (a) quantity of production, (b) quality of production, (c) versatility and (d) dependability. These qualities are judged periodically and the extra compensation adjusted accordingly. The main objection to this plan is that it leads to grievances because of the personal judgments involved.

CONDITIONS IN WAREHOUSE OPERATIONS

The application of the incentive plan used in this thesis will be to a warehouse located at the Atlantic Steel Company in Atlanta, Georgia. The business that is now known as the Atlantic Steel Company was founded in Atlanta in 1901. Its products were limited at that time to rolling small strip sizes of steel. Its rolling facilities have been expanded so that at the present time it is able to produce a wider range of sizes and shapes as well as a general increase in tonnage. It also produces wire and wire products and has facilities to form and fabricate both cold and hot steel. The steel for these operations is furnished by three open hearth furnaces which produced 200,000 tons of steel in 1950. A new electric furnace is being built in 1952 to bring this total to over 300,000 tons. The company is located in the northwest section of Atlanta on a site of 200 acres of land which contains 65 acres of buildings with approximately 750,000 square feet of floor space. Eight diesel and steam locomotives and cranes handle 1000 railroad cars each month to bring in the raw material and take out the finished products. The Atlantic Steel Company provides jobs for 2000 employees, with an annual payroll of over five million dollars.

The operations and shipping procedure in the warehouse used in this study are representative of the methods used in many warehouses storing rolled steel products. The particular warehouse that will be used in this study is one that stores rolled shapes, cut length strips, large rolled flats and other associated products.

Material is shipped both by rail and by truck. The warehouse is equipped with material handling equipment used to load box cars, gondolas, van type and open body trucks. This material handling equipment includes an overhead bridge crane, dump trucks, lift trucks and assorted hand tools.

The routing of orders from customers to shipping has no direct bearing on this study and will not be included. The study will begin with the orders when they reach shipping. Orders that are for small amounts are accumulated for purposes of economy and are rolled together. All material produced, however, is either for direct customer's order or for stock to be carried in order to fill small orders. Material rolled for orders considerably exceeds that for stock. All requirements for orders and for stock are scheduled on a master rolling schedule (see Figure 1) that is distributed to the rolling mills and to the warehouse. This rolling schedule includes instructions for straightening, bundling, shearing or other operations that are to be performed in the warehouse.

The procedure for putting material into the warehouse is for an overhead five (5) ton bridge crane to pick up the material in bundles as it is produced on the rolling mills and place it in storage. Material that does not require any supplementary operations except storage is either placed directly in open top storage bins or placed in front of stock bins where it can later be placed in these bins by hand. Material that requires supplementary operations is stored temporarily until these operations are performed. After the supplementary operations have been performed the material is placed in storage awaiting shipment.

A release for each order is sent to the warehouse after the material is rolled, and all warehousing operations performed, giving the date and conveyance for shipping.

The nature of the business of the Atlantic Steel Company is such that orders are filled ranging from one piece of angle weighing fifteen pounds to an order for several hundred thousand pounds of steel. The single piece can be picked up by hand and placed on a truck, but the order for several hundred thousand pounds must be picked up with the overhead crane in seven thousand pound bundles and placed directly in open trucks or gondola type railroad cars.

As the release of the order is received by the warehouse for shipment, it is given to a "fill order" crew which usually consists of two men. These men must be familiar with the location of the stock so that they can locate it in the least possible time. If an order is very large it is marked at the rolling mill for the customer and placed in large bundles in the warehouse where it can be located and shipped with a minimum of delay. When these orders are released for shipment the order fillers merely locate these bundles, check them for quantity, tag them with shipping tags and notify the cranefollower that they can be loaded.

In the case of small orders a single crane pick up from the producing mill of seven thousand pounds may contain a large number of orders. When these orders are released for shipment they are given to the order filling crew who go to the large bundles and count out the number of pieces of each size and shape from the various bundles that appear on the order. The order is assembled in one place, wired for separation purposes, tagged for shipment and the crane-follower is notified that it can be loaded.

As can be seen from these two extremes of order size, the order filling procedure and standards must be sufficiently flexible to meet these needs. The application of standards to this type of procedure must also be flexible enough to properly reward the employee for his actual efforts rather than on the average based on the chance frequency with which these orders of varying weights occur. This shall be considered in detail later.

SELECTION OF THE INCENTIVE PLAN

Much thought should be given to the choice of individual or group standards regardless of which type of incentive plan is used. There are advantages and disadvantages in each for different applications. The two main considerations that determine which application should be made are:

1. Shall the employee's extra pay reflect

his performance ratio over the entire day?

2. Shall the pay ratio of the department reflect the ratio of only work performed on standard or shall it reflect the departmental operations as a whole?

Individual standards when applied usually are of the type that the employee must be taken off the standard during the shift when any delays or unavailability of work causes the employee to be idle until more work is scheduled. This is because a small amount of idle time, especially if it occurs at the beginning of the day, will prevent the operator from making extra pay during the remainder of the day unless the idle time is removed from the standard. This effect of delays on standard work in many instances is not given as much consideration as it warrants. For instance, if an employee starts work on standard and works for one hour and his machine breaks down for an appreciable length of time, he will not have the opportunity to earn incentive that day if he has to make up the production of the time he has lost. Unless the employee can move to another job he should not be held responsible for the time lost. This loss is the responsibility of the supervision. Under the group application the employee will have incentive to move to other jobs and perform them until his regular activity can be resumed. These conditions arise often in a warehouse.

The other consideration concerns the question of which ratio should be reflected in the extra pay. Should it reflect the ratio of only the hours worked on standard or should it reflect the ratio of the entire day? If the extra pay is reflected on the ratio of the entire shift it will immediately bring to the attention of supervision the effect of delays, poor work scheduling and late starting or early quitting on the job.

The group incentive when applied to cover all employees in the group during the entire shift will also reflect the performance ratio of the group rather than individual earning ratios for possibly only part of the shift. There are techniques whereby it is possible to show this overall departmental ratio over the entire shift with individual standards, but extra pay is usually not computed from this ratio. In the event the departmental ratio is consistently low it signifies that either the employees are not working at an incentive rate or that the work load is not sufficient to keep the working forces busy. If excess working forces are being used it is seldom difficult to make transfers as this will increase the extra pay of the employees remaining in the group.

It is because of the above reasons and the ready adaptability of the group incentive plan to cost distribution that it will be used in this application.

The type of incentive plan used in this application is a combination of some of the desired characteristics of the five types of plans previously discussed. The control features of the plan are more like those found in the point plans. The earnings curve is an adaptation of a variable premium sharing plan (see Figure 2). The fact that the earnings curve starts at zero production is a reflection of the benefits of the piece rate type of plan where extra pay is figured for all levels of production. The earnings curve is similar to the earnings under the standard hour plan at the expected performance ratio of between 1.15 and 1.33.

TIME STUDY PROCEDURE

Method studies were made of all operations before time studies were begun. It was discovered that different methods and procedures were used by different men in performing the same operation. These differences were both in method and number of men used and varied between different turns and within the same turn. Close work and cooperation with all three foremen were required to determine the best way to do the different jobs. A standard method and working force for each job was agreed on and the working force taught this method. No job was time studied until after the job was performed as it would be after the standards were effective. Several engineers were able to make studies concurrently in the early stages as several operations were being performed at the same time. As studies were completed on some of the operations there were times when no studies could be made. The foremen were informed as to what operations needed studying and as these operations were performed, the Industrial Engineering Department was notified in turn and studies made.

Time studies were made on each operation as if it were the only standard to be applied. The normal time study procedure was used in determining the elements to be timed. Both continuous and snap back methods were used. The snap back method was used for jobs when it was possible to list the elements in the order in which they would be performed before the job was performed. This was adaptable to such operations as straightening material, loading box cars and other repetitive operations. The continuous method was used primarily in order filling studies. The procedure for this job was for the order filling crew to get all orders that were ready for release and locate the material in the warehouse. They would then either count out the number of pieces ordered, or, in the event of large orders, mark the entire bundle and signal for a pickup by the crane. The continuous time study method was found to be best suited for this type of study.

The procedure used for summarizing the time studies was to add all the observed times for each element and divide by the number of readings taken. The average was multiplied by the rating factor to obtain the elemental normal time. On repetitive operations the elements were totaled using the frequency with which they occurred to obtain the normal cycle time. Allowances were applied to the normal cycle time to arrive at the standard time. This procedure is illustrated in another section in the thesis.

DERIVATION OF STANDARDS

Studies were made and summarized over a period of several months. The derivation of the standards for most of the operations did not present too difficult a problem. These standards were derived by combining the elements in the frequency they occurred. The normal procedure of applying allowances was followed to arrive at the standard.

Standard data was used where practical in this application. Standard times were developed by time study for such operations as required in loading box cars. These constant elements are for opening the box car, securing the gang board that allows entrance to the box car, removing the gang board, closing the box car doors and sealing them. These constant times were allowed in all box car loading standards on a full box car load, regardless of the method used for placing the material in the car. This same procedure was followed in other types of box car loading and resulted in great savings in time study and more equitable standards. This procedure is explained more fully as it is used in the derivation of the standards.

The derivation of the standards for filling and shipping orders presented the most difficult problem. This is due to the variables involved in the materials handled, the various methods required and the variation in the frequency of certain elements. This necessitated publishing standards for elements whose frequency of occurrence could not be adequately predicted.

The derivation of the standards for filling orders and loading these orders in trucks, gondolas and box cars warrants detailed analysis in this thesis as the principles used are necessary to the success of the completed incentive plan.

It was determined that the same standard for all weights could not be used for filling orders and loading these orders on trucks, gondolas and box cars as orders of various weights were handled by different methods. Orders for weights less than that of a crane pick up from the mill must be filled by counting the number of pieces or bundles ordered.

The following are the elements for filling orders of bundled material by hand:

Element Number	Description
1	Walk from order table to material required.
2	Count out number of bundles in order and

Element Number	Description
	place on separators on floor.
3	Put on two tie wires and shipping tag.
4	Walk to next stock area for next size or product shown on orders.

Note: Elements 2, 3 and 4 are performed until all pieces or ordered sizes and shapes are obtained for all orders.

5	Return to order assignment area for more orders.

The following summary indicates the location of the time study for each element:

Element Number	Derivation of Standard Time	Location of Data
1	Time Study	Table I
2	Time Study	Table II
3	Time Study	Table III
4	Time Study	Table IV
5	Time Study	Table V

The description of the elements shows that there is not an exact sequence in which the elements occur. This means that to arrive at the standard it is necessary to estimate the frequency of these elements. The frequency of elements 1 and 5 was determined by observing the average number of orders filled on each order filling trip. This was found to be approximately ten. A minor variation in this number does not significantly effect the accuracy of the standard. The frequency of elements 3 and 4 could not be accurately determined as there is no consistency in shapes per order or sizes per shape. An attempt was made to determine this frequency with favorable results over a period of several weeks. However, as the economic situation changed, customers began ordering a different sequence of shapes, sizes and weight. This necessitated publishing a separate standard for elements 3 and 4. The derivation of the standard for filling orders by hand is shown in Table VI.

Orders that are filled by the preceding method must be loaded on trucks. The trucks may belong to the customer, trucking lines or Atlantic Steel Company. The material is loaded on Atlantic Steel Company trucks if it is to be delivered by the company or shipped to the customer by railroad in less than carload lots.

Large orders that are picked up in full bundles at the producing mill are taken directly out of the warehouse by the overhead crane and loaded in open body trucks and gondola type railroad cars. It should be noted that although the elements for this operation occur in the same frequency they do not occur in proportion to the weight handled. Large orders were found to necessitate a pick-up with the overhead crane about every 4000 pounds; however, there are a large number of orders that are less than 4000 pounds that are shipped by truck. This weight division was determined by analyzing the weights placed on trucks for each pick up. A thorough investigation was not made as there is a possibility that the shipping procedure will be changed to affect this figure. If a standard was published assuming a pick up average of 4000 pounds it would be impossible to make standard on a load of, for instance, 1000 pounds. This is because, inasmuch as the standard will be published per thousand pounds, only one fourth as much credit would be received for loads of 1000 pounds as those of 4000 pounds, although it takes the same length of elapsed time.

This inequity was partially overcome by publishing two standards for this operation. One standard is used for less than 4000 pounds per truck while the other is for over 4000 pounds.

The following are the elements for loading open body trucks and gondola type railroad cars with an overhead crane.

Element Number	Description
1	Hook crane chains to bundle of material.
2	Travel to weighing scales.
3	Weigh and record weight.
4	Travel to truck or gondola.

Element Number	Description
5	Place bundle of material in truck or gondola.
6	Return to material for next load.

The following summary indicates the location of the detailed time study for each element:

Element Number	Derivation of Standard Time	Location of Data
1	Time study	Table VII
2	Time study	Table VIII
3	Time study	Table IX
4	Time study	Table X
5	Time study	Table XI
6	Time study	Table XII

The elements for this operation occur in sequence with the same frequency for all elements. Derivation of the standard for loading open body trucks and gondola type railroad cars for both above and below 4000 pounds is shown in Table XIII.

Emphasis on this point has been placed on the procedure that required a fill order crew to accumulate the ordered material that can be loaded directly with the overhead crane. The overhead crane in the basic material handling equipment in this warehouse. It is used to pick up finished production from the rolling mill and place it in the warehouse. Whenever possible, it is used to load material for shipping or to position it for easy handling. An example of this positioning is loading box cars with a lift truck. This method is used for material that has been sheared to lengths which are short enough to permit loading on lift truck forks and passage through the box car door opening.

The following are the elements for loading box cars using a lift truck:

Element Number	Description
1	Open box car doors and place gang board in entrance to box car.
2	Pick up bundle with lift truck.
3	Travel to box car with load.
4	Place load in box car.
5	Return to material for next load.
6	Remove gang board, close box car doors and seal.

The following summary indicates the location of the detailed time study for each element:

Element Number	Derivation of Standard Time	Location of Data
1	Standard Time	Table XIV

Element Number	Derivation of Standard Time	Location of Data
2	Time study	Table XV
3	Time study	Table XVI
4	Time study	Table XVII
5	Time study	Table XVIII
6	Standard data	Table XIX

The derivation of the standard for loading box cars using a lift truck is shown in Table XX. The summation of the elements 2 through 5 plus the standard data elements of 1 and 6 constitute the total standard.

A standard for loading box cars by hand will be given to show how standard data can be applied to all methods. Loading box cars by hand is likely to be the most uneconomical method for handling material. In actual practice only a small percentage of the total shipments is handled by this method. It is used mostly on partial car loads when the other material in the order must be shipped in box cars or when the customer is not equipped to unload gondolas or large unit bundles. Whenever possible the material is shipped in open body trucks or gondolas.

The following are the elements for loading box cars by hand:

Element Number	Description
1	Open box car doors and place gang board

Element Number	Description
	in entrance to box car.
2	Place bundle with overhead crane convenient for handling and remove tie wires.
3	Pick up approximately 100 pounds.
4	Walk to box car.
5	Place load in box car.
6	Return to material for next load.
7	Remove gang board, close box car door and seal.

The following summary indicates the location of the detailed time study for each element:

Element Number	Derivation of Standard Time	Location of Data
1	Standard data	Table XIV
2	Time study	Table XXI
3	Time study	Table XXII
4	Time study	Table XXIII
5	Time study	Table XXIV
6	Time study	Table XXV
7	Standard data	Table XIX

The derivation of the standard for loading box cars by hand is shown in Table XXVI. The summation of the elements 2 through 6 plus the standard data elements 1 and 7 constitute the total standard. It should be noted that the overhead crane positions the material as near as possible to the box car for easy handling.

These illustrations are not intended to cover all shipping operations. The purpose of the illustrations used is to show the principles used in applying standards to shipping operations. The standards for various shapes and sizes of products were determined by finding the proportions between the normal time for handling these various shapes and sizes.

REPORTING PROCEDURE

Adequate attention should be given to the reporting procedure of an incentive plan. It should be remembered that part of the cost of an incentive plan is the reporting and computing expense. An incentive plan that requires a complex and expensive reporting and computing system will nullify much of the savings resulting from the coverage of the plan. Errors in posting incorrect earnings will also cause unpleasantness among the employees.

A reporting procedure was established for this incentive plan that is designed to be as economical as possible and yet to report all information that is necessary. All work performed in the warehouse is reported on small reporting tickets. (see Figure 3). Three types of tickets were designed to cover all work. The three types of tickets used are for stocking or filling orders, loading material for shipment, bundling and banding material or welding coiled hoop. These tickets are designed to include all information needed for computing earned hours for each operation. These tickets are a great aid in the cost distribution as will be explained later. Other forms used include a report which is filled out by the foremen and shows each employee's clock number, name, rate of pay, occupation, account number and total hours worked (see Figure 4). A summary sheet is used for all work performed.

The foreman keeps at his desk all types of tickets and the working force report sheet. The timekeeper and weigher keeps the summary sheet for the tickets and the report for straightened material. The foreman fills out all of the tickets as follows:

Fill Order and Stocking Ticket

A. Fill Order. When the foreman receives a release for an order he makes out a regular warehouse order tag to be attached to the material when it is shipped. This tag is kept at the foreman's desk until he is ready to have the order filled by the fill order crew. At the same time this tag is made out the foreman fills out the fill order ticket. The foreman puts the shift number, whether the order was filled from open or hand bins and whether the order was filled with hand bundles or loose material. The product, size, weight and number of tags used is given. These tickets are kept in a convenient place by the foreman during the turn. After the necessary information has been recorded from the order, the ticket is placed in a folder and kept at the foreman's desk until the order is shipped.

B. Stocking Ticket. The same ticket as is used for filling orders is used for stocking material. The foreman does not stock bins by written request, but does so when the supply warrants the restocking. He removes the mill ticket from the large bundle to be stocked and uses the information from this source to fill out the stocking ticket. The ticket is filled out after the material has been placed in stock and shows the type of storage bin, product, weight and turn.

Shipping Ticket

When the customer's rail or motor equipment arrives to pick up the ordered material the foreman removes the order from the folder and uses it to see that the order is filled properly. After the order is loaded the foreman makes out the shipping ticket that is used for incentive pay purposes. He writes on this ticket the type of conveyance into which the material was loaded, the method used in loading and in the case of a box car, whether the material was bundled, unbundled or coiled, the product and the weight.

Bundling and Banding or Welding Coil Hoop Ticket

A. Bundling and Banding. The ticket for this operation is made out by the foreman as soon as the job is performed. The foreman lists the turn, product, size, pieces per bundle, the number of tie wires or cold bands and the number of finished bundles.

B. Welding Coil Hoop. The same ticket is used for this job as for bundling and banding. The foreman lists the size, strands per coil and the number of completed coils.

Straightener Operator's Report

This report is filled out by the straightener operator on the job. He gives the straightener machine name, product, size and length of material being straightened. As the material is brought to the machine by the overhead bridge crane the operator lists the weight on his report as it appears on the mill tag on the bundle. At the end of the turn this report is given to the foreman who checks it against the production report of the mill.

At the end of the turn the timekeeper-weigher secures from the foreman all tickets, the straightener operator's report and the working force report. The tickets as they are received from the foreman do not contain the standard for the work performed. The timekeeper-weigher transcribes the information from all tickets onto the daily production summary report. All tickets of like nature are summarized at this time for easier use in computing extra pay. He also writes the standard for all the operations. The total number of tags used for filling orders are reported with the standard for this operation.

All the forms listed in the above procedure are filled out for each turn. The timekeeper-weigher delivers all reports of work performed to the Chief Weigher whose office computes total hours earned and extra pay.

COST DISTRIBUTION SYSTEM

A simple labor cost for work performed on a production job may be obtained by dividing the labor cost of the working force by the work produced. The cost can then be expressed in terms of dollars per item or unit of weight produced. If the job is on standard, a theoretical cost may be computed on the job before it is produced by dividing the standard days production by the labor cost per day. As long as the operator maintains this standard the labor cost will remain the same. The direct labor cost will either decrease or remain the same with an increase in production depending on the type of incentive rate of pay used. If there is a decrease in production below standard, the cost will increase as most companies maintain a guaranteed base rate.

Jobs which are performed in an infrequent manner during the day present a more difficult problem of cost distribution. It is impractical to attempt to keep the time separated for the performance of these jobs. Attempts have been made to do this by various prorating systems whereby total labor cost over a given period of time is charged to the product by either estimates of time spent or tonnage produced. This system has proved unsatisfactory in many instances due to the error in estimating time and the fact that cost may not be proportional to tonnage produced. The warehouse used in the example given in this thesis shows that labor cost is not directly proportional to tonnage handled. This can be seen in the standards that are published for different methods. It also necessitated publishing different standards for loading orders below and above 4000 pounds.

The problem was to devise a cost system that would reflect the true cost of the operation in a warehouse for both shipping and warehousing. The reporting procedure uses tickets to report the various operations that are performed in the warehouse. The total earned hours are determined by standards from these tickets. The total of all tickets and material reported on the straightener operator's report shows all the work performed in the warehouse. The total hours worked by the working forces are the man hours applied against the standard to determine the performance ratio. This performance ratio is used to determine the extra pay. The cost of all operations will be influenced by this ratio.

The actual cost distribution is made once a month as this is the policy on cost throughout the plant. All figures used in the cost distribution are accumulated on a daily basis so that the cost figures for the preceding month may be published by the 3rd or 4th of the month. It was discussed that because of the inaccuracy of the results, the policy of dividing the daily labor cost by the tonnage produced or the policy of prorating the entire labor cost at the end of the month on a tonnage basis was not adequate. Neither of these two methods are used with the proposed cost distribution system.

The policy of cost distribution in the warehouse before this application was to charge the actual hours worked on the various operations during the month. At the end of the month the cost for each operation was determined by dividing the labor cost by the work accomplished expressed in the desired units. This procedure required an elaborate cost accounting number system with the use of work cards. Work cards were made on each employee as he was assigned a specific job. This card was assigned a charge number that signified to what account the operation was to be charged. Each time an employee changed jobs it was necessary to make out a new work card showing hours worked and the new account number. All of these cards were accumulated and total charges posted to the account. At the end of the month all charges were posted and all production was determined. The cost per unit or ton was calculated from this ratio. Any error in changing work cards and account numbers resulted in errors in cost. Due to the type of work performed in the warehouse this error was very large. This type of cost system required a large clerical force to distribute all the cards.

With the new cost distribution system the work card system is no longer needed. All labor cost including incentive pay to all employees in the warehouse is charged to one account as long as the employees work anywhere in the warehouse. At the end of the month the total of this account is used as the total direct labor cost for the entire warehouse.

The performance ratio is computed every day for the warehouse. Each ticket shows the earned hours for that operation. After the performance ratio has been calculated and used for extra pay purposes the tickets are used for cost distribution. The tickets are very useful in making this distribution. The tickets are first divided into two parts. One part consists of all the tickets reflecting charges to be made against shipping and the other part all charges for warehousing. Each part is then divided into all the categories needed for the final cost distribution. These tickets plus the earned hours for straightening material, which is a warehousing charge, represent all the work performed. The earned hours appearing in each pile is recorded on a spread sheet (see Figure 5) under that particular category. All charges are added daily to check this total against the total earned hours used in computing total earned hours used in computing the performance ratio. If the totals are the same no error has been made.

At the end of the month the daily summary sheet is totaled for all earned hours of each category and a grand total of all categories is made. This grand total represents the earned hours of all the work performed in the warehouse during the month. It is necessary at this time to secure the total direct labor cost in the warehouse for the month. This total is shown in one account and is easily obtained. The total direct labor cost is then divided by the total earned hours to determine the average cost of each earned hour for the month. It should be noted that if the performance ratio is exactly 1.00 every day and no extra pay earned during the month, the cost per earned hour will be the same as the average base rate of the warehouse. This is not likely to exist. The lower the performance ratio during the month the higher will be the cost of the earned hours. This factor alone shows the management more than anything else the effect a low performance ratio will have on cost. It shows that the true cost is reflected in the cost per earned hour rather than in the base rate of the job.

After the average cost per earned hour has been calculated it is necessary to determine the cost of each category. This can be done by multiplying the average cost per earned hour by the earned hours in each category. This calculated cost may be checked by adding all the parts to arrive at the total cost figure used. A cost report is sent to the Cost Department once a month giving this cost distribution (see Figure 6).

This cost computation is not based on a theoretical cost figure as is used in many cost estimates that are used with standards. It is based rather on actual results. Cost estimates should be made when possible but should always be checked with actual cost figures. The application of this type of cost distribution will also show to what extent the size of orders shipped and the methods used affect the final cost.

INSTALLATION OF THE INCENTIVE PLAN

The actual installation of the incentive plan is very important to its success. The success of an incentive plan is not entirely dependent upon the accuracy of the standards. Its success also depends upon the availability of extra pay for extra effort. Therefore, it should not be installed until all work is performed using the proper method and the correct working forces. Failure to do this will invariably result in a low performance ratio, regardless of the effort by the employees to earn extra pay.

The first step was to have a meeting of all of the supervisors of the department to be placed on standard. The incentive plan was explained to them in detail. Emphasis was not placed on the mechanics of the derivation of the standards, but rather on the amount of work required for extra pay and the effect of enforced idle time of the employee on his earnings opportunity. An explanation of this brought out the fact that an incentive plan will not, and is not intended to, lessen the foreman's responsibility for scheduling both work and working forces. In fact, a low performance ratio can result from poor planning by the supervisor as well as lack of effort on the part of the employee. The discussion with the supervisors at this time emphasized to them how much effect their efforts will have on the employee's earnings.

The next meeting was held with all the employees affected by the incentive plan, or their representatives. It is good practice to have all supervisors at this meeting so that each understands the information given the other. At this meeting the complete incentive plan was explained to the employees. The procedure for computing earned hours of work by multiplying the standard by the production was illustrated by an example. It was explained that the earned hours divided by the actual hours worked is the performance ratio which determines the extra pay. Examples were used to show that the more work performed in the shorter period of time result in more extra pay.

The example used in this thesis is a group incentive. This was explained to the employees along with the reasons for choosing a group incentive plan. Cooperation is a big factor in the success of a group incentive. It was thoroughly explained to the employees that the efforts of each would effect the extra pay for the group. The men were also told that extra pay will be computed each day for every turn and the extra pay will be posted on the day following the day for which the pay was earned.

It has been the experience of the writer with this and other incentive plans that a detailed explanation of all standards in the incentive plan will result in confusion without developing the desire to produce a high performance ratio. This is especially true for a plan that contains a large number of standards. It has been found to be more beneficial to talk about the incentive plans in terms of general policy. It is important to thoroughly explain that all attendance hours of the employees, except those of the craneman, in this application are charged against the standard. This emphasizes to the employee that he will be expected to work at any task which is available when his particular job is completed or delayed for any reason.

This incentive plan was installed on a trial period for thirteen weeks. If at any time during this period any questions arose pertaining to the plan, a meeting could be called and these questions discussed. These meetings that are held after the incentive plan has been installed are usually more helpful than the initial meeting. Before the incentive plan is installed the employees are unaware of the actual work required on a group basis and do not have many questions until after the plan has been in effect for a week or more. This emphasizes the need for thorough follow up on all incentive plans. A point that invariably arises in these meetings is that certain standards do not have the same earnings opportunity as others. These jobs should be investigated immediately. It is possible that the job is not being performed by the standard method or that some work elements of set up, servicing, or obtaining supplies were not adequately covered by the standards. If neither of these reasons appear to be the cause it is necessary to make an all day production check.(see Figure 7)

The production check is a continuous time study that begins when the employee should begin work and ends at the normal quitting time. The study records the delay in starting at the beginning of the shift, the time spent working, all avoidable delays, rest and personal time taken during the day, enforced idle time, contingencies and the time the employee quits work at the end of the turn. The operator is speed rated during the day to determine at what rate he is working compared to normal. After the production check has been made it is necessary to analyze the study and explain to the employee and his foreman the results of the study. The standards may be adjusted on evidence from this study or an explanation made to the employee as to why the standard is adequate.

CONCLUSIONS

The application of incentive plans in the warehouses at Atlantic Steel Company was lagging behind the application of plans in its producing departments. This condition was much the same as exists throughout industry. Some applications of incentives had been made in the warehouse, but the plans were far from being complete both from the aspect of incentive coverage and cost controls which should be an integral part of the incentive plan. Management realized the benefits that could be gained from an application which would provide an opportunity for warehouse employees to earn extra pay for extra effort and at the same time provide management with a complete cost distribution system in the warehouse of the same accuracy as is available on most production operations.

After a careful analysis of the procedures that are used in a warehouse it was discovered that the usual procedures for group incentives and cost distribution in industrial operations are ineffective for warehousing operations by reason of the following characteristics:

1. Customers' orders have wide ranges both as to the types of products ordered and the quantities within these orders. This is because of the fact that various customers are engaged in widely

different businesses.

2. Jobs that are performed in a warehouse cannot at times be performed in the same repetitive manner as can many production jobs.
3. The lack of repetition in the performance of jobs makes it difficult to keep an accurate cost record of these operations.
4. The varying work load demand of the operations performed in a warehouse makes it necessary to develop an incentive plan to provide an earnings opportunity to meet these conditions.

This study considered the following procedures to accommodate the characteristics of warehousing operations and at the same time proceeded in a manner consistent with accepted principles of job evaluation and sound wage policies.

1. Established standards for orders that have a variation in the frequency distribution of the weights and products.
2. Developed an incentive plan whereby the earned extra pay will be reflected by the ratio of the total earned hours

to the total man hours worked on standard.

3. Devised a reporting procedure in conjunction with a cost distribution system.

The procedures described in this thesis resulted in a group incentive plan and a cost distribution system applied in a warehouse at the Atlantic Steel Company. Its overall purpose was to provide an opportunity for employees to earn extra pay for extra effort and to provide management with a much needed cost record for shipments and operations performed in the warehouse. It is believed that the principles used in this application are also usable with slight modification for similar conditions.

The installation of an incentive plan or the end of the trial period does not mean that the plan will not require further attention. All new operations performed by the employees covered by the plan should be placed on standard as soon as possible. A constant search should also be made for better methods and more efficient material handling equipment. As these new methods are perfected proper standards should be installed.

Too much emphasis cannot be placed on the maintenance of proper standards. As more work is performed than is covered by the standard or as method improvements are made, the standards should be adjusted immediately. Failure to do this will result in standards that are either "too tight" or "too loose." Standards that are not adequate will result in a decrease in effort of the employees. Once these exceptional earnings have been made for any length of time it is difficult to adjust the standard. Administration of the standard should be such that no standard is used for an operation that is not performed by the standard method and under standard conditions.

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APPENDIX I

SAMPLE CALCULATIONS

SAMPLE CALCULATION OF WEEKLY EARNINGS

Hours Worked:

Monday	3PM - 11PM	8 hrs.	Friday	7AM - 3PM	8 hrs.
Tuesday	3PM - 12PM	9 hrs.	Saturday	not worked	
Wednesday	3PM - 11PM	8 hrs.	Sunday	not worked	
Thursday	7AM - 3PM	8 hrs.	TOTAL	41 hours	

Hourly Rate of Pay: $1.50 per hour

Calculation of Percent Incentive Pay:

A = total earned standard hours.
B = total hours worked.
C = average earned standard hour per hour worked.

therefore $\frac{A}{B} = C$

Example: A = 54.5 std. hrs. B = 41 hours.

therefore $\frac{54.5}{41} = 1.33$ See Figure 2 for percent extra pay - 30%

Calculation of Weekly Pay:

Base pay equals (41 x $1.50)	= $61.50
Extra pay equals (30% x $61.50)	= $18.45
Average hourly rate equals (79.95/41)	= $ 1.95
Overtime pay:	
Tuesday 1 hr. overtime (½ x $1.95)	= $ 0.97
Thursday 7AM - 3PM (4 x $1.95)	= $ 7.80

Total Weekly Earnings equals:
($61.50 plus $18.45 plus $0.97 plus $7.80) = $88.72

NOTE: The above procedure conforms with the Federal Wage and Hour Act and the Walsh-Healey Bill.

APPENDIX II

TABLES

TABLE I: TIME STUDY READINGS

ELEMENTS:
Walk From Order Table to Material Required.

Number	Reading	Number	Reading	Number	Reading
1	1.07	11	.52	21	.66
2	1.45	12	.98	22	1.12
3	.72	13	1.63	23	.98
4	.63	14	.77	24	.60
5	.79	15	.73	25	.70
6	1.26	16	.71		
7	.67	17	.51		
8	.70	18	.62		
9	.55	19	.98		
10	.51	20	.76		

Total time study	20.62 minutes
Number of observations	25
Average of observations	0.825 minutes
Observed rating factor	1.10
Normal time	0.907 minutes
Standard time	1.075 minutes

Allowances:

Rest	5.0 %
Personal	7.5 %
start up	3.0 %
clean up	3.0 %
	18.5 % total

TABLE II: TIME STUDY READINGS

ELEMENT:
Count Out Number of Bundles in Order and Place on Separators on Floor. (minutes per bundle)

Number	Reading	Number	Reading	Number	Reading
1	.41	11	.35	21	.32
2	.38	12	.35	22	.30
3	.30	13	.37	23	.35
4	.46	14	.45	24	.57
5	.47	15	.33	25	.33
6	.51	16	.28	26	.30
7	.32	17	.40	27	.45
8	.31	18	.26	28	.37
9	.47	19	.58	29	.51
10	.48	20	.31	30	.21

Total time study	11.40 minutes
Number of Observations	30
Average of observations	.380 minutes
Observed rating factor	1.10 minutes
Normal time	.418 minutes
Standard time	.537 minutes

Allowances:

Rest	15.0 %
Personal	7.5 %
start up	3.0 %
clean up	3.0 %
	28.5 % Total

TABLE III: TIME STUDY READINGS

ELEMENT:
Put on Two Tie Wires and Shipping Tag.

Number	Reading	Number	Reading	Number	Reading
1	.82	11	.59	21	.53
2	.54	12	.56	22	.59
3	.57	13	.56	23	.64
4	.87	14	.33	24	.40
5	.83	15	.95	25	.63
6	.56	16	.74	26	.58
7	.78	17	.73	27	.58
8	.63	18	.80	28	.50
9	.73	19	.65	29	.51
10	.70	20	.64	30	.43

Total time study	18.97	minutes
Number of observations	30	
Average of observations	.632	minutes
Observed rating factor	1.10	
Normal time	.695	minutes
Standard time	.858	minutes

Allowances:

Rest	10.0 %
Personal	7.5 %
start up	3.0 %
clean up	3.0 %
	23.5 % Total

TABLE IV: TIME STUDY READINGS

ELEMENT:
Walk to Next Stock Area for Next Size or Product Shown on Order.

Number	Reading	Number	Reading	Number	Reading
1	.73	11	.50	21	.65
2	.70	12	.64	22	.37
3	.77	13	.51	23	.70
4	.50	14	.38	24	.96
5	.45	15	.30	25	.47
6	.32	16	.75	26	.72
7	.73	17	.44	27	.42
8	.50	18	.47	28	.84
9	.36	19	.42	29	.74
10	.72	20	.72	30	.70

Total time study	17.89 minutes
Number of observations	30
Average of observations	.596 minutes
Observed rating factor	1.10
Normal time	.656 minutes
Standard time	.777 minutes

Allowances:

Rest	5.0 %
Personal	7.5 %
start up	3.0 %
clean up	3.0 %
	18.5 % Total

TABLE V: TIME STUDY READINGS

ELEMENT:
Return to Order Assignment Area for More Orders.

Number	Reading	Number	Reading	Number	Reading
1	1.99	11	1.61	21	1.07
2	1.16	12	1.05	22	.88
3	1.61	13	1.15	23	1.05
4	1.25	14	1.02	24	1.71
5	0.92	15	1.42	25	.96
6	1.45	16	.96	26	1.25
7	.75	17	1.14	27	.97
8	1.43	18	1.26	28	1.45
9	1.55	19	1.01	29	.98
10	1.22	20	.96	30	1.00

Total time study	36.23 minutes
Number of observations	30
Average of observations	1.208 minutes
Observed rating factor	1.10
Normal time	1.329 minutes
Standard time	1.575

Allowances:

Rest	5.0 %
Personal	7.5 %
start up	3.0 %
clean up	3.0 %
	18.5 % Total

TABLE VI: DERIVATION OF STANDARD

OPERATION:
Filling Orders of Bundled Material by Hand.

Element Number	Description of Element	Standard Time
1	Walk from order table to material required.	1.075
2	Count out number of bundles in order and place on separators on floor.	0.537
3	Put on two tie wires and shipping tag.	0.858
4	Walk to next stock area for next size or product shown on order.	0.777
5	Return to order assignment area for more orders.	1.575
	Total of elements 1 and 5	2.650
	Total of elements 3 and 4	1.635
	Element 2	0.537
	Working force	2 men

Average orders per trip 10

Elements 1 and 5 $\frac{2.650 \times 2}{.60 \times 10} = .883 \frac{\text{standard hours}}{\text{100 order}}$

Elements 3 and 4 $\frac{1.635 \times 2}{60} = .0545 \frac{\text{standard hours}}{\text{item or order}}$

Element 2 $\frac{0.537 \times 2}{.60} = 1.790 \frac{\text{standard hours}}{\text{100 bundles}}$

TABLE VII: TIME STUDY READINGS

ELEMENT:
Hook Crane Chains to Bundle of Material.

Number	Reading	Number	Reading	Number	Reading
1	.69	11	.50	21	.73
2	.60	12	.65	22	.60
3	.56	13	.86	23	.52
4	.79	14	.70	24	.70
5	.50	15	.78	25	.83
6	.55	16	.87	26	.68
7	.63	17	.82	27	.50
8	.60	18	.86	28	.54
9	.77	19	.83	29	.43
10	.73	20	.84	30	.52

Total time study	20.18 minutes
Number of observations	30
Average of observations	.673 minutes
Observed rating factor	1.10
Normal time	.741 minutes
Standard time	.915 minutes

Allowances:

Rest	10.0 %
Personal	7.5 %
start up	3.0 %
clean up	3.0 %
	23.5 % Total

TABLE VIII: TIME STUDY READINGS

ELEMENT:
Travel to Weighing Scales.

Number	Reading	Number	Reading	Number	Reading
1	.75	11	.65	21	.56
2	.62	12	.66	22	.74
3	.76	13	.48	23	.68
4	.77	14	1.17		
5	.61	15	.90		
6	.73	16	1.05		
7	.76	17	.94		
8	.67	18	.88		
9	.55	19	.81		
10	.92	20	.82		

Total time study	17.48 minutes
Number of Observations	23
Average of observations	.750 minutes
Observed rating factor	1.15
Normal time	.863 minutes
Standard time	1.027 minutes

Allowances:

Rest	5.0 %
Personal	7.5 %
start up	3.0 %
clean up	3.0 %
	18.5 % Total

TABLE IX: TIME STUDY READINGS

ELEMENT:
Weigh and Record Weight.

Number	Reading	Number	Reading	Number	Reading
1	.51	11	.75		
2	.41	12	.45		
3	.59	13	.51		
4	.48	14	.65		
5	.32	15	.38		
6	.50	16	.56		
7	.46	17	.71		
8	.71	18	.40		
9	.73				
10	.65				

Total time study	9.77	minutes
Number of observations	18	
Average of observations	.542	minutes
Observed rating factor	1.10	
Normal time	.597	minutes
Standard time	.708	minutes

Allowances:

Rest	5.0 %
Personal	7.5 %
start up	3.0 %
clean up	3.0 %
	18.5 % Total

TABLE X: TIME STUDY READINGS

ELEMENT:
Travel to Truck or Gondola.

Number	Reading	Number	Reading	Number	Reading
1	.39	11	.35	21	.46
2	.40	12	.45	22	.41
3	.50	13	.41	23	.50
4	.44	14	.42	24	.54
5	.49	15	.40	25	.52
6	.51	16	.49	26	.47
7	.54	17	.43	27	.50
8	.44	18	.49	28	.43
9	.40	19	.47	29	.43
10	.39	20	.49	30	.44

Total time study	13.59	minutes
Number of observations	30	
Average of observations	.452	minutes
Observed rating factor	1.15	
Normal time	.521	minutes
Standard time	.616	minutes

Allowances:

Rest	5.0 %
Personal	7.5 %
start up	3.0 %
clean up	3.0 %
	18.5 %

TABLE XI: TIME STUDY READINGS

ELEMENT:
Place Bundle of Material in Truck or Gondola.

Number	Reading	Number	Reading	Number	Reading
1	.82	11	.64	21	.48
2	.60	12	.50	22	.61
3	.54	13	.65	23	.49
4	.49	14	.52	24	.52
5	.48	15	.42	25	.37
6	.84	16	.89	26	.64
7	.50	17	.85	27	.42
8	.90	18	.56	28	.44
9	.92	19	.61	29	.46
10	.66	20	.78	30	.64

Total time study	18.24 minutes
Number of observations	30
Average of observations	.607 minutes
Observed rating factor	1.15
Normal time	.698 minutes
Standard time	.861 minutes

Allowances:

Rest	10.0 %
Personal	7.5 %
start up	3.0 %
clean up	3.0 %
	23.5 %

TABLE XII: TIME STUDY READINGS

ELEMENT:
Return to Material for Next Load.

Number	Reading	Number	Reading	Number	Reading
1	.31	11	.34	21	.41
2	.39	12	.42	22	.47
3	.25	13	.33	23	.38
4	.35	14	.54	24	.40
5	.32	15	.33	25	.44
6	.33	16	.42	26	.44
7	.36	17	.38	27	.54
8	.37	18	.48	28	.38
9	.40	19	.52	29	.33
10	.35	20	.31	30	.42

Total time study	11.71 minutes
Number of observations	30
Average of observations	.390 minutes
Observed rating factor	1.20
Normal time	.463 minutes
Standard time	.555 minutes

Allowances:

Rest	5.0 %
Personal	7.5 %
start up	3.0 %
clean up	3.0 %
	18.5 % Total

TABLE XIII: DERIVATION OF STANDARD

OPERATION:
Loading Open Body Trucks and Gondola Type Railroad Cars Using an Overhead Crane.

Element Number	Description of Element	Standard Time
1	Hook crane chains to bundle of material.	.915
2	Travel to weighing scales.	1.022
3	Weigh and record weight.	.708
4	Travel to truck or gondola	.616
5	Place bundle of material in truck or gondola.	.861
6	Return to material for next load.	.555
	Total of elements 1, 2, 3, 4, 5 and 6	4.677 min.
	Working force	1 man

DERIVATION OF STANDARD

Trucks or Gondolas when total weight per truck is greater than 4000 pounds.

$$\frac{4.677}{60 \times 4.000} = .0195 \quad \frac{\text{std. hours}}{1000\ \#}$$

Trucks or Gondolas when total weight per truck is less than 4000 pounds.

$$\frac{4.677}{60} = .0780 \quad \frac{\text{std. hours}}{\text{truck}}$$

TABLE XIV: TIME STUDY READINGS (Standard Data)

ELEMENT:
Open Box Car Doors and Place Gang Board in Entrance to Box Car.

Number	Reading	Number	Reading	Number	Reading
1	3.16				
2	3.32				
3	2.57				
4	3.60				
5	2.78				
6	2.28				

Total time study	17.71	minutes
Number of observations	6	
Average of observations	2.95	minutes
Observed rating factor	1.00	
Normal time	2.95	minutes
Standard time	3.79	minutes

Allowances:

Rest	15.0 %
Personal	7.5 %
start up	3.0 %
clean up	3.0 %
	28.5 % Total

TABLE XV: TIME STUDY READINGS

ELEMENT:
Pick Up Bundle With Lift Truck.

Number	Reading	Number	Reading	Number	Reading
1	.42	11	.25	21	.40
2	.25	12	.33	22	.21
3	.32	13	.37	23	.26
4	.28	14	.38	24	.15
5	.27	15	.23	25	.29
6	.30	16	.17	26	.27
7	.32	17	.22	27	.22
8	.26	18	.43	28	.22
9	.24	19	.28	29	.32
10	.33	20	.21	30	.36

Total time study	8.56 minutes
Number of observations	30
Average of observations	.285 minutes
Observed rating factor	1.05
Normal time	.299 minutes
Standard time	.356 minutes

Allowances:

Rest	5.0 %
Personal	7.5 %
start up	3.0 %
clean up	3.0 %
	18.5 % Total

TABLE XVI: TIME STUDY READINGS

ELEMENT:
Travel to Box Car With Load.

Number	Reading	Number	Reading	Number	Reading
1	.43	11	.34	21	.41
2	.43	12	.30	22	.31
3	.45	13	.35	23	.38
4	.39	14	.37	24	.39
5	.38	15	.36	25	.36
6	.34	16	.38	26	.40
7	.41	17	.32	27	.37
8	.56	18	.35	28	.38
9	.37	19	.31	29	.35
10	.36	20	.41	30	.46

Total time study	11.44 minutes
Number of observations	30
Average of observations	.382 minutes
Observed rating factor	1.20
Normal time	.457 minutes
Standard time	.542 minutes

Allowances:

Rest	5.0 %
Personal	7.5 %
start up	3.0 %
clean up	3.0 %
	18.5 % Total

TABLE XVII: TIME STUDY READINGS

ELEMENT:
Place Load in Box Car.

Number	Reading	Number	Reading	Number	Reading
1	.82	11	.76	21	.76
2	1.13	12	1.43	22	1.09
3	.98	13	.62	23	1.58
4	1.03	14	1.08	24	1.68
5	1.21	15	1.23	25	1.65
6	1.46	16	.73	26	1.16
7	1.52	17	.70	27	1.02
8	1.37	18	.78	28	1.00
9	1.31	19	1.56	29	1.38
10	.73	20	1.00	30	1.42

Total time study	34.21 minutes
Number of observations	30
Average of observations	1.100 minutes
Observed rating factor	1.05
Normal time	1.058 minutes
Standard time	1.425 minutes

Allowances:

Rest	10.0 %
Personal	7.5 %
start up	3.0 %
clean up	3.0 %
	23.5 % Total

TABLE XVIII: TIME STUDY READINGS

ELEMENT:
Return to Material for Next Load.

Number	Reading	Number	Reading	Number	Reading
1	.31	11	.36	21	.36
2	.24	12	.30	22	.39
3	.37	13	.31	23	.37
4	.41	14	.35	24	.36
5	.29	15	.33	25	.34
6	.32	16	.37	26	.29
7	.34	17	.36	27	.36
8	.28	18	.32	28	.34
9	.30	19	.38	29	.33
10	.31	20	.38	30	.32

Total time study	10.09 minutes
Number of observations	30
Average of observations	.336 minutes
Observed rating factor	1.25
Normal time	.420 minutes
Standard time	.497 minutes

Allowances:

Rest	5.0 %
Personal	7.5 %
start up	3.0 %
clean up	3.0 %
	18.5 % Total

TABLE XIX: TIME STUDY READINGS (Standard Data)

ELEMENT:
Remove Gang Board, Close Box Car Door and Seal.

Number	Reading	Number	Reading	Number	Reading
1	4.16				
2	3.14				
3	2.71				
4	2.49				
5	4.60				
6	2.72				

Total time study	19.82	minutes
Number of observations	6	
Average of observations	3.30	minutes
Observed rating factor	1.00	
Normal time	3.30	minutes
Standard time	4.23	minutes

Allowances:

Rest	15.0 %
Personal	7.5 %
start up	3.0 %
clean up	3.0 %
	28.5 % Total

TABLE XX: DERIVATION OF STANDARD

OPERATION:
Loading Box Cars Using a Lift Truck.

Element Number	Description of Element	Standard Time
1	Open box car doors and place gang board in entrance to box car. (Standard data)	3.790
2	Pick up bundle with lift truck.	.356
3	Travel to box car with load.	.542
4	Place load in box car.	1.425
5	Return to material for next load.	.497
6	Remove gang board, close box car door and seal. (Standard Data)	4.230
	Total of elements 2, 3, 4 and 5	2.820
	Total of elements 1 and 6.	8.020
	Working force	2 men

DERIVATION OF STANDARD

Average weight per trip 1,875 pounds.
Average weight per box car 45,000 pounds.

Elements 2, 3, 4 and 5 $\frac{2.820 \times 2}{60 \times 1,875} = 0.0501 \frac{\text{standard hours}}{\text{1000 pounds}}$

Elements 1 and 6 $\frac{8.020 \times 2}{60 \times 45,000} = 0.0059 \frac{\text{standard hours}}{\text{1000 pounds}}$

Total $0.0660 \frac{\text{standard hours}}{\text{1000 pounds}}$

TABLE XXI: TIME STUDY READINGS

ELEMENT:
Place Bundle With Overhead Crane Convenient for Handling and Remove Tie Wires:

Number	Reading	Number	Reading	Number	Reading
1	2.44				
2	3.78				
3	2.70				
4	2.19				
5	2.83				
6	2.36				
7	1.62				

Total time study	18.92 minutes
Number of observations	7
Average of observations	2.71 minutes
Observed rating factor	1.10
Normal time	2.97 minutes
Standard time	3.67 minutes

Allowances:

Rest	10.0 %
Personal	7.5 %
start up	3.0 %
clean up	3.0 %
	23.5 % Total

TABLE XXII: TIME STUDY READINGS

ELEMENT:
Pick Up Approximately 100 pounds.

Number	Reading	Number	Reading	Number	Reading
1	.21	11	.26	21	.24
2	.37	12	.23	22	.19
3	.26	13	.22	23	.18
4	.28	14	.26	24	.21
5	.33	15	.31	25	.26
6	.31	16	.15	26	.22
7	.22	17	.33	27	.22
8	.29	18	.13	28	.17
9	.40	19	.26	29	.25
10	.28	20	.21	30	.26

Total time study	7.51 minutes
Number of observations	30
Average of observations	.250 minutes
Observed rating factor	1.15
Normal time	.288 minutes
Standard time	.355 minutes

Allowances:

Rest	10.0 %
Personal	7.5 %
start up	3.0 %
clean up	3.0 %
	23.5 % Total

TABLE XXIII: TIME STUDY READINGS

ELEMENT:
Walk to Box Car.

Number	Reading	Number	Reading	Number	Reading
1	.10	11	.10	21	.10
2	.12	12	.10	22	.10
3	.11	13	.10	23	.10
4	.09	14	.11	24	.09
5	.10	15	.10	25	.11
6	.10	16	.11	26	.09
7	.10	17	.10	27	.10
8	.10	18	.10	28	.11
9	.10	19	.09	29	.10
10	.10	20	.09	30	.09

Total time study	3.01 minutes
Number of observations	30
Average of observations	.100 minutes
Observed rating factor	1.25
Normal time	.125 minutes
Standard time	.160 minutes

Allowances:

Rest	15.0 %
Personal	7.5 %
start up	3.0 %
clean up	3.0 %
	28.5 % Total

TABLE XXIV: TIME STUDY READINGS

ELEMENT:
Place Lead in Box Car.

Number	Reading	Number	Reading	Number	Reading
1	.06	11	.07	21	.06
2	.08	12	.06	22	.06
3	.07	13	.07	23	.06
4	.05	14	.07	24	.07
5	.07	15	.06	25	.06
6	.06	16	.06	26	.07
7	.07	17	.05	27	.05
8	.06	18	.06	28	.05
9	.05	19	.07	29	.08
10	.06	20	.04	30	.06

Total time study	1.86 minutes
Number of observations	30
Average of observations	.062 minutes
Observed rating factor	1.25
Normal time	.077 minutes
Standard time	.096 minutes

Allowances:

Rest	10.0 %
Personal	7.5 %
start up	3.0 %
clean up	3.0 %
	23.5 % Total

TABLE XXV: TIME STUDY READINGS

ELEMENT:
Return to Material for Next Load.

Number	Reading	Number	Reading	Number	Reading
1	.12	11	.12	21	.13
2	.14	12	.13	22	.13
3	.14	13	.13	23	.14
4	.12	14	.12	24	.14
5	.14	15	.14	25	.13
6	.13	16	.13	26	.13
7	.12	17	.14	27	.15
8	.12	18	.13	28	.13
9	.14	19	.14	29	.14
10	.13	20	.13	30	.14

Total time study	3.97 minutes
Number of observations	30
Average of observations	.133 minutes
Observed rating factor	1.30
Normal time	.172 minutes
Standard time	.204 minutes

Allowances:

Rest	5.0 %
Personal	7.5 %
start up	3.0 %
clean up	3.0 %
	18.5 % Total

TABLE XXVI: DERIVATION OF STANDARD

OPERATION:
Loading Box Cars by Hand.

Element Number	Description of Element	Standard Time
1	Open box car doors and place gang board in entrance to box car.	3.790
2	Place bundle with overhead crane convenient for handling and remove tie wires.	3.670
3	Pick up approximately 100 pounds.	.355
4	Walk to box car.	.160
5	Place load in box car.	.096
6	Return to material for next load.	.204
7	Remove gang board, close box car door and seal.	4.230
	Total of elements 3, 4 5 and 6	.815
	Total of elements 1 and 7	8.020
	Element 2	3.670
	Working force	1 man

DERIVATION OF STANDARD

Average weight per trip 100 pounds.
Average weight per crane load 4,000 pounds.
Average weight per box car 45,000 pounds.

Elements 3, 4, 5 and 6 $\frac{0.815 \times 1}{60 \times .0100} = 1.358 \frac{\text{standard hours}}{\text{1000 pounds}}$

Element 2 $\frac{3.670 \times 1}{60 \times 4.000} = 0.015 \frac{\text{standard hours}}{\text{1000 pounds}}$

Element 1 and 7 $\frac{8.020 \times 2}{60 \times 45.000} = 0.006 \frac{\text{standard hours}}{\text{1000 pounds}}$

Total 1.379 $\frac{\text{standard hours}}{\text{1000 pounds}}$

APPENDIX III

FIGURES

SHEET № ______________ DATE ______________

MILL ROLLING SCHEDULE

GRADE	SIZE BILLET	LENGTH BILLET	CHARGED WEIGHT	SIZE PRODUCT	SHEARING LENGTH FT.	SHEARING LENGTH IN.	NUMBER PCS PER BUNDLE	ORDER NUMBER	CUSTOMER	FINISHED WEIGHT
				ANGLES						
1010	A	72"	34,500	1" x 1" x 1/8"	20	6		6666	KING PLOW	30,000
				STRIP						
1085	B	60"	115,000	3/4" x 18 GA	3 STRANDS PER			COIL	SOUTHERN CO	100,000
								6668		
				BANDS						
1070	B	40"	57,000	1" x 1/8" *	6	3 1/4	15	6669	U. S. NAVY	50,000
				FLATS						
1005	L	20"	230,000	3" x 1"	20	0		6670	KING PLOW	200,000
					RESHEAR TO 9'-11"					
* DEFENSE ORDER										

FIGURE 1 – SAMPLE MASTER ROLLING SCHEDULE

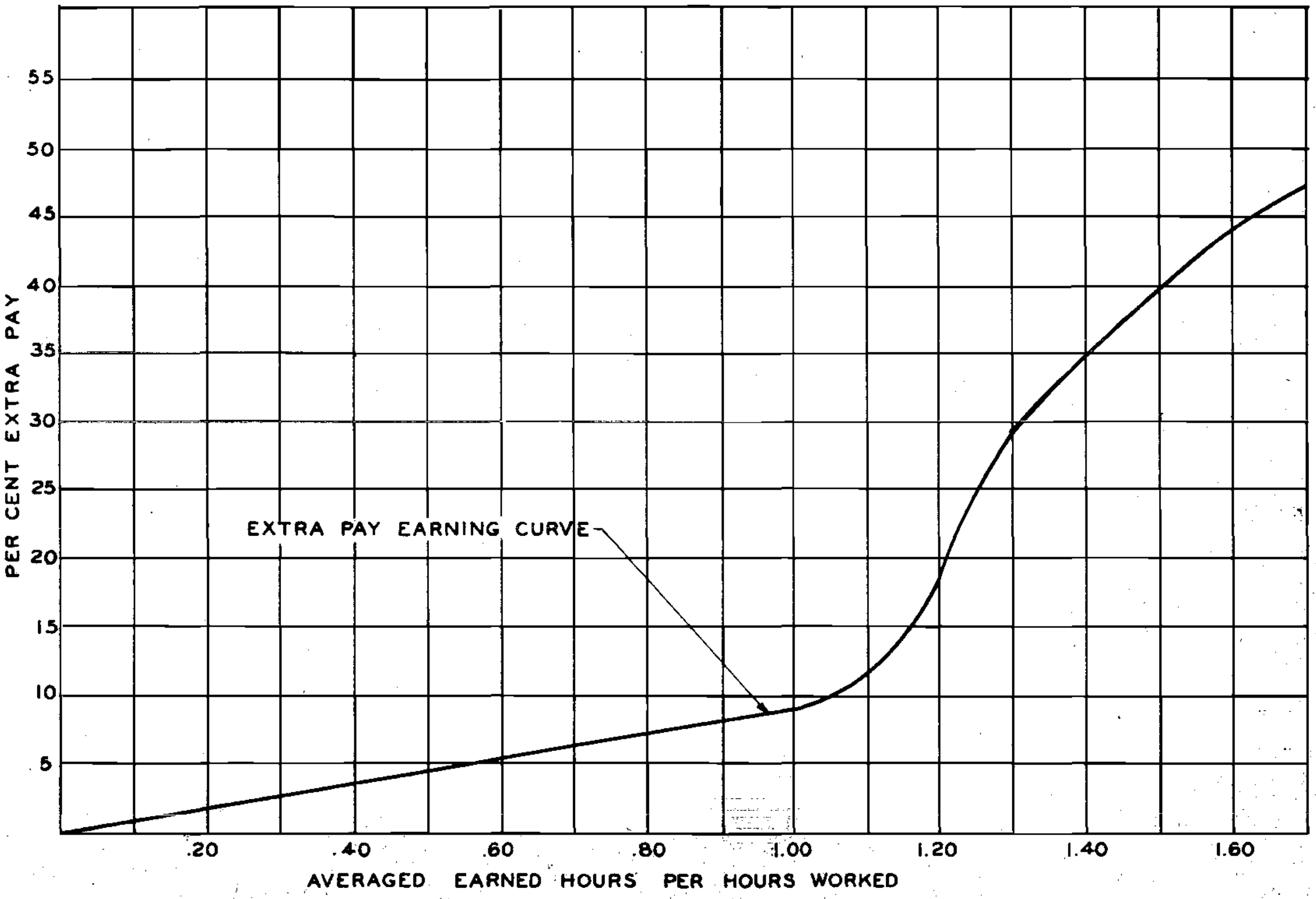

FIGURE 2 – PER CENT EXTRA PAY CURVE

LOAD BOX CAR ____ HAND ____ L. TRUCK ____ DUMP ____

LOAD TRUCK ____ OPEN ____ VAN ____ GONDOLA ____

TURN	HAND BUNDLED	LOOSE
TAGS	PRODUCT	SIZE
WEIGHT	STANDARD NUMBER	STANDARD

NUMBER BUNDLES ____

TURN	PRODUCT		SIZE	
TAGS	PCS PER BDL	Nº TIE WIRES	Nº HOT BDS.	Nº COLD BDS.
STANDARD NUMBER			STANDARD PER 100 BUNDLES	

STOCKING ____ FILL ORDER ____

OPEN ____ HAND BINS ____

TURN	HAND BUNDLED	LOOSE
TAGS	PRODUCT	SIZE
WEIGHT	STANDARD NUMBER	STANDARD

FIGURE 3 – REPORTING TICKETS

_______________WAREHOUSE
FORCE REPORT

DATE ________ TURN ________ FOREMAN ____________ % BONUS PAY ________

CLOCK NUMBER	NAME	OCCUPATION	ACCOUNT NUMBER	BASE PAY	HOURS WORKED	

THIS PART OF REPORT IS USED TO SHOW
BASE RATE, BASE PAY, BONUS PAY & TOTAL PAY

FIGURE 4 - WORKING FORCE REPORT

WAREHOUSE COST SUMMARY SHEET

MONTH ________

MONTHLY DIRECT LABOR COST DISTRIBUTION

DATE	ALL DIFFERENT COST ACCOUNTS LISTED HERE														TOTAL	
	← EARNED HOURS →															
	WHSE	SHIP	WHSE	SHIP	WHSE	SHIP	WHSE	SHIP	WHSE	SHIP	WHSE	SHIP	WHSE	SHIP	WHSE	SHIP
TOTALS																
DOLLARS																

$$\frac{\text{TOTAL DOLLARS IN DIRECT LABOR ACCOUNT } \$\rule{3cm}{0.4pt}}{\text{TOTAL EARNED HOURS}} = \frac{\$\rule{3cm}{0.4pt}}{\text{EARNED HOURS}}$$

FIGURE 5 – COST SUMMARY SHEET